1) The electronic polarizability of the Ar atom has a value of $1.7*10^{-40}$ F $m^2$. What is the static dielectric constant of the solid Ar if its density is 1.8 g $cm^{-3}$ and its atomic mass is 39.95 g $mol^{-1}$? ( Avogadro's number = $6.02*10^{23}$ $mol^{-1}$ ).

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2) Consider a CsCl crystal which has CsCl unit cell crystal structure (one $Cs^+$_$Cl^-$ pair per unit cell) with a lattice parameter (a) of 0.412 nm. The electronic polarizability of $Cs^+$ and $Cl^-$ ions are $3.35*10^{-40}$ F $m^2$ and $3.4*10^{-40}$ F $m^2$ respectively, and the mean ionic polarizability per ion pair is $6*10^{-40}$ F $m^2$. What is the dielectric constant? (Given that $N = I/a^3$).

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3) In a certain atom, the positive charge in the nucleus has a value of $q=3.2*10^{-19}$ C, the radius of the atom $R=6*10^{-9}$ cm, E=20 KV/cm and $N= 3*10^{19}$ $cm^{-3}$. Find the equilibrium distance $d_E$, the dielectric susceptibility and diclectric constant resulting from electronic polarization.

4) An atom with a radius of $5*10^{-8}$ cm has a positive charge in the nucleus with a magnitude of $4*10^{-18}$C. If the atom is subjected to an electrical field of 15KV/cm, calculate the equilibrium distance "d" according to the electronic polarization assuming a number of molecules per unit volume of $25*10^{20}$. Calculate also the electric dipole moment, the polarization, the dielectric susceptibility and the dielectric constant after equilibrium.

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5) Find the polarizability of a certain ion in $Fm^2$ assuming that the number of molecules per unit volume is $22*10^{18}$ $cm^{-3}$. The dielectric constant of the ion is 4.

$\alpha = \frac{3}{N} \frac{\varepsilon_r - 1}{\varepsilon_r + 2} \varepsilon_0$

$\alpha = 6.634 \times 10^{-37}$ $Fm^2$

1) For the orientation polarization with sinusoidal applied field, find the expressions for $\varepsilon'_r$ and $\varepsilon''_r$.

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2) With the help of equations 1-6, 1-8 and 2-4, derive equations to describe the variation of the dielectric constant with frequency. Assume that $\alpha_0 = 6*10^{-36}$ F $m^2$ and $N=25*10^{22}$ $m^{-3}$. Plot this variation when the frequency varies in the range from $0.001/\tau$ to $1000/\tau$.

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3) Obtain the dielectric loss per unit capacitance in a capacitor in terms of the loss tangent. Obtain the phase difference between the current through the capacitor and that through $R_p$. What is the significance of $\delta$?

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4) Calculate the power dissipated per unit volume of cross-linked polyethylene, XLPE (typical power cable insulator) at 60 Hz at a field of 100 kV $cm^{-1}$ if $\varepsilon'_r$ and tan $\delta$ of XLPE are 2.3 and $3 * 10^{-4}$ respectively.